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ABSTRACT

The consistent reports on gender inequity in science achievement have led to a search for more effective strategies for correcting the imbalance. This study is part of a search which sought to investigate whether or not the cooperative-concept mapping technique improves the science achievement of girls. A non-equivalent control group quasi-experimental design involving three intact groups was adopted. Three schools and 362 Junior Secondary School (JSS) II (equivalent to 8th grade) students in Nnewi Urban, Anambra State of Nigeria constituted the sample. The subjects in each of the three groups were tested before and after treatment which spanned 8 weeks. The Test of Integrated Science Achievement (TISA) was used for data collection. Results showed that the cooperative-concept mapping strategy significantly improved the achievement of girls in the selected integrated science concepts. Contains 33 references. (Author/JRH)

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Remediation of Gender Inequity in Science in a Developing Country: An Experiment with Cooperative Concept Mapping

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The consistent reports on gender inequity in science achievement have led to a search for more effective strategies for correcting the imbalance. This study is part of this search which sought to investigate whether or not, the Cooperative: Concept-mapping technique will improve the science achievement of girls. A non-equivalent control group quasi-experimental design involving three intact groups was adopted. Three schools and three hundred and sixty-two (362) JSS II students in Nnewi urban, Anambra State of Nigeria constituted the sample. The subjects in each of the three groups were tested before and after treatment which spanned eight weeks. Test of Integrated Science Achievement (TISA) which had a reliability coefficient of internal consistency of 0.81 was used for data gathering. Results showed that the cooperative-concept mapping strategy improved significantly the achievement of girls in the selected integrated science concepts.

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Remediation of Gender Inequity in Science in a Developing Country : An Experiment with Cooperative Concept Mapping.

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Introduction

Gender as a factor in science achievement has for some time now generated a lot of concern in science educators. This concern arose from emerging data on differential gender achievement in science. A large pool of research evidence abound of this differential achievement of boys and girls in science; (Flemming & Malone, 1983; Erickson & Erickson, 1984; Nworgu, 1988; Ezeife, 1990; Levin, Sabar & Libman, 1991; NAEP, 1991&1992) and the general consensus of these research reports is that boys out perform girls in science. Attempts have been made through research to find ways of bridging this gap or at least reducing to some extent. In this regard, NAEP (9191) reported that the science of girls has increased significantly since 1982. This according NAEP may reflect the of recent efforts in trying to stimulate the interest of girls in science. However, stronger efforts are still needed since this increase has not been great enough to significantly reduce the yawning gap . Evidence shows that boys still out perform girls at higher proficiency levels (NAEP, 1991, 1992).

The foregoing position therefore underscores to intensify efforts to provide girls with the necessary learning experiences / activities that will boost their morale, increase their interest ,help them to develop better attitudes toward science with their attendant improved science achievement. The method of instruction in the science classroom at this juncture is considered very important . Methods which allow active participation in the learning process may be particularly valuable in not only addressing interests and knowledge but also their declining self- esteem . Unfortunately, in many countries especially Nigeria, science instruction is still at the level where the teacher is the sole actor while the students are passive recipients of all that the teacher is able to hand down to them . This tends to go contrary to the current constructivist's minds on hands on activity oriented science instruction . Contemporary developments have pointed to the facts that science knowledge construction can be socially mediated . The implication that all learning takes place in a social context . This has been established through the successful use of cooperative in the science classroom (Johnson & Johnson, 1982 ; Okebukola, 1986 ; Lonning , 1993 ; Lazarowitz ,Hertz-Lazarowitz & Baird, 1994) .

Cooperative learning strategy can be used in combination with other strategies to produce greater achievement gains in science . For example Okebukola & Jegede (1988) and Okebukola (1989 & 1992) reported that concept mapping within a cooperative learning environment in the science classroom promotes achievement . On its individual merit , concept mapping which is a metacognitve strategy has also been reported to enhance meaningful learning of science concepts (Okebukola & Jegede , 1989; Okebukola, 1990; Wandersee, 1990; Novak, 1990a, 1990b) .

Concept mapping is a model of instructional strategy developed by Novak and his associates in 1972. It is a meta learning technique for assisting to organize information about science concepts in a meaningful manner in order to facilitate meaningful leaning. It is based on the premise that concepts do not exist in isolation but interrelate with others to make meaning . Organizing new concepts / information into a form that shows these interrelationships helps learners make mental connections . The steps in concept mapping were clearly explicated by Novak & Gowin (1984; pp. 34 - 44).

One common feature of research on cooperative learning and concept mapping is that the gender question has hardly been explored . Besides, the focus of previous studies in these areas were on single science subjects. Neither of these made use of integrated science. Again, most of these studies took their sample from either senior high school or degree students while the lower grades at both primary and secondary school levels have hardly been used .

It is therefore necessary to find out whether concept mapping built into cooperative learning environment will create the same effect across all the science areas since girls have been reported to have greater for physical sciences. Integrated science will make them see science as a whole rather than as separate entities . This may serve to motivate girls to enroll in the different branches science at higher levels irrespective of whether they are physical or biological sciences .This study therefore, sought to find out whether cooperative concept mapping will be efficacious in improving the achievement girls in integrated science . Specifically, this study sought to answer the questions: (1) Will the teaching of selected integrated science concepts using cooperative concept mapping significantly improve the achievement of girls in integrated science ? (2) Will there be any significant effect on the achievement of girls and boys in the selected integrated science concepts due to mode of concept mapping ?

METHOD

Sample

The sample for the study consisted of a total of 362 Junior Secondary School (JS) II (equivalent to Grade 8) students who made up nine intact classes (three from each sample school) from these schools in Nnewi Urban, Anambra State of Nigeria. Junior Secondary Class II students who fell within the age were used as sample for this study because the JSI students would not have learnt enough integrated science at the time of the study and the JS III class being an examination class will be too examination conscious to be ideal for the study. To ensure equivalence of sampled schools in terms of education standards, the population was restricted to state-owned secondary schools in Nnewi Urban in which the state government admits students, funds and recruits teachers.

The three sampled schools (1 boy only 1 girls only and 1 mixed) were selected by purposive sampling procedure from a list of eight schools in Nnewi Urban. The schools that were so selected met the following criteria: had at least one integrated science teacher; the school authorities gave permission for their schools to be used in the study and gave strong indication of their willingness to provide all necessary assistance and cooperation; the integrated science teachers in the classes to be used for the experiment accepted to undergo training; the schools were relatively easily accessible and allowed for close and effective monitoring of activities by the researcher; and had up to three streams of JS II students.

Since there was no indication of ability streaming, three intact classes were selected by simple balloting from each sample school and were randomly assigned to treatment groups. Of the three treatment groups, two (treatment group 1 (TG1) and Treatment group 2 (TG2) formed the experimental groups while the remaining (TG3) formed the control group. The first experimental group (TG1) consisted of 125 students (55 girls and 70 boys); the second (TG2) was made up of 121 students (49 girls and 72 boys) while the control group (TG3) had 116 students (51 girls and 65 boys). All these students participated fully in the study by undergoing pre-treatment training, attending classes and took the pretest and posttest. The concepts - Energy, Ecology and Pollution were selected for the study.

Instrumentation

The instrument used to collect relevant data for this study was the Test of Integrated Science Achievement (TISA). This was a 42-item multiple choice achievement test which covered three cognitive levels of Bloom's (1976) taxonomy of educational objectives - knowledge, comprehension and application. In constructing these items, an initial pool of eighty items was generated and were scrutinized by several specialists namely: two practising integrated science teachers; and four experts in educational measurement and evaluation as well as science education. These experts observed and made sure that the items covered the universe of content (Cronbach, in Thorndike (ed) 1971) including the subject matter content and the instructional objectives (Gronlund, 1976). They also did face validation to ensure that the items measured what they were meant to measure. Of the eighty items only fifty-six survived their scrutiny. These were trial-tested on a sample of ninety-two JsS II students randomly selected from two schools (one male only, one female only) in Nnewi urban. These students used had been taught the three concepts to be used for the study and were similar to those for whom the instrument was intended. These students were however not used for the main study. The results of the trial-test were analysed using two contrasted criterion groups each comprising 33 1/3 % of the trial sample and selected from the two extremes of the score continuum respectively (Nworgu, 1990). 42-item with difficulty indices lying between 0.30 and 0.70 as recommended by Ohiche and Akeju (1988); and having discrimination indices lying between -0.20 and +1.00 as well as having positive distractor indices were selected as the final version of TISA. This yielded a Kuder-Richardson (KR-20) reliability coefficient of internal consistency of 0.81 and served as both the pre-test and post-test.

Research Design

This study was expected to establish a cause-effect relationship. To this end it was a quasi-experiment of a non-equivalent-control group design involving two independent variables - mode of instruction, which was manipulated and gender which cannot be manipulated. This involved a two-way, 3-mode of instruction [lecture/Discussion, + Cooperative Concept Mapping (LD + CCM); Lecture/Discussion + Individualistic Concept-Mapping (LD + I CM) and Lecture/Discussion (LD) only X 2-gender (Male and Female) factorial arrangement.

PROCEDURE

All the three regular integrated science teachers of JSS II (one from each sample school) participated in the study. These teachers were trained prior to the experiment. The training was done by the researcher using the Achievement in Integrated Science Instructional Guide (AISIG) designed by the researcher for the study. This intensive training which lasted four weeks was meant to equip the teachers with the knowledge of how to share students into cooperative groups, how to score students' concept maps, how to train the students to construct concept maps as well as give them relevant information about the study.

After the teachers completed their training, their level of competence in concept-mapping was evaluated by asking them to construct their own concept maps using concepts they were familar with. These were scored and corrections made as necessary. They were also asked questions on how they intended to share the cooperative group students into groups. Training was considered successful when all the participating teachers were able to explain how to share students into cooperative groups, when they scored an average of eighty percent each from the construction of four maps as well as when there was a unanimous agreement among them that they understood and can implement the experimental procedures. Because Nigeria had the peculiar problem of not having enough integrated science teachers, only the available ones (3 on the whole) were trained. The researcher therefore made extra efforts to see that the few available teachers attained the required level of proficiency in concept-mapping before the training of students commenced.

The treatment was carried out during the regular integrated science periods and spanned eight weeks at the end of which students were given an alternative but equivalent form of the pre-achievement TISA as a post-achievement test. This was achieved by reshuffling the sequence of numbering of the final version of TISA which was used for the pre-test. This arrangement served to eliminate the possibility of any response set being carried over from the pre-test to the post-test. While the experiment went on, the researcher paid frequent unannounced visits to the experimental and control groups to ensure strict compliance to the rules of the study.

RESULTS

The data for this study were analysed using means and standard deviations and in addition a 3 x 2 analysis of covariance since random assignment of subjects to experimental and control conditions was not achieved. Pre-test scores were used as covariates to remove extraneous variations from the gain scores thereby increasing measurement precision. A further analysis with a multiple classification analysis (MCA) provided adjusted group means (i.e. adjusted for independents and covariates) and also the amount and direction of variations due to each independent variable where significant main effects exist.

The results showed that (a) the statistically significant difference in the achievement of girls and boys was due to the main treatment effects between the experimental and control groups in favour of the experimental ($F = 30.15$, $p < .0001$). (b) There was a statistically significant gender difference in achievement which may be attributed to mode of concept mapping ($F = 12.39$, $p < .001$). This was confirmed by the significant interaction between gender and treatment ($F = 4.02$; $p < .02$). While it did not matter which mode was used for the boys, girls performed significantly better when taught with cooperative concept mapping. The superior performance of girls may therefore be attributed to cooperative concept mapping.

DISCUSSION

The main objectives of this study was to investigate (I) whether there will be any significant effect on the achievement of girls and boys in the selected integrated science concepts due to mode of concept mapping. (ii) whether cooperative concept mapping will significantly improve the achievement of girls in the selected integrated science concepts. The findings indicated that (I) there was remarkable improvement in the achievement of girls and boys as a result of concept mapping irrespective of the modes of construction. (ii) Boys were not much affected by the mode of concept mapping while girls recorded remarkable improvement with cooperative concept mapping.

Results of this study therefore provides ample empirical evidence in support of previous findings of Okebukola & Jegede (1989) and Okebukola (1990) Wandersee, (1990) and Novak (1990a, 1990b) which attested to the efficacy of concept mapping in facilitating student's achievement in science. Of greater importance is the fact that this study has also provided evidence in support of earlier research findings of Okebukola and Jegede (1988) and Okebukola (1989 and 1992) on the efficacy of concept mapping with a cooperative learning environment in the science classroom. However, the interesting aspect of this study which is worthy of note is the introduction of the gender factor which was not explored in those other studies. Girls who were hitherto reported to under achieve in science had superior achievements when they were taught with cooperative concept mapping strategy.
Perhaps, this superior achievement of girls recorded in this study may be attributed to the sharing of ideas and peer tutoring (Okebukola & Jegede, 1989) inherent in the cooperative learning groups. This finding contracts Erickson & Erickson (1984), Nworgu (1988), Ezeife (1990) and Levin, et al (1991) who earlier reported male superiority in science and goes to suggest that cooperative concept mapping may be a viable strategy in arresting the under-achievement of girls in science.

As mentioned earlier in this write up gender differences were found to begin to appear in the middle grades (Catsambio 1995) and the gender gap in science achievement widens from age 9 and 13 (Kahle and Meece 1994). If this strategy was found to improve the performance of girls who fall within the age range 10 - 14 it is therefore logical

to assume that cooperative concept mapping strategy could serve as a very effective intervention strategy to help boost the achievement of girls while bridging the gender gap in science. The result of this study therefore seem to have provided to some extent an answer to the question of female under-achievement in science which has for a long time now created the gender gap in science achievement.

Result of this study has an obvious implication for science education. Practicing teachers are encouraged to explore the use of this strategy in teaching girls.

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